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THE NORDA HEMISPHERIC MIXED LAYER MODEL SYSTEM (HMLMS): A FUNCT--ETC(U)
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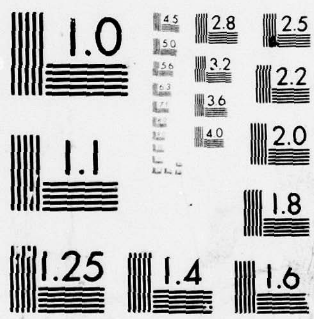

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NORDA TECHNICAL NOTE 45

THE NORDA HEMISPHERIC MIXED-LAYER MODEL SYSTEM (HMLMS): A FUNCTIONAL DESCRIPTION

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April 1979

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ABSTRACT

This technical note describes a forecast model for the thermal structure of the upper ocean developed for Fleet Numerical Weather Central (FNWC) by NORDA Code 322. Brief discussions of the capabilities and limitations of the model, its software design, and its impacts on and interfaces with the FNWC operational system are given.

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I. INTRODUCTION

A. PURPOSE OF THIS FUNCTIONAL DESCRIPTION

This functional description of the NORDA Hemispheric Mixed Layer Model System (HMLMS) is written to provide:

1. A statement of the basic capabilities and limitations of the model.

2. A statement of the computer resources required.

3. A statement of the data fields required.

4. A description of the basic function of each program module, the I/O file structure, and the flow of program control and data through the system.

5. A basis for the development of system tests.

B. PROJECT REFERENCES

1. Clancy, R. M. (1979). A Model of Diurnal Variability of the Ocean-atmosphere System in the Undisturbed Trade Wind Regime. Tech. Report SAI-79-807-WA, Science Applications, Inc., 8400 Westpark Drive, McLean, VA.

2. Jerlov, N. G. (1951). Optical Studies of Ocean Waters. Rept. of the Swedish Deep Sea Exp., Vol. 3, No. 1, p. 3-59 (Goteborg).

3. Martin, P. J. (1976). A Comparison of Three Diffusion Models of the Upper Mixed Layer of the Ocean. NRL Memorandum Report 3399, Naval Research Laboratory, Washington, DC, 62 p.

4. Martin, P. J. and G. O. Roberts (1977). An Estimate of the Impact of OTEC Operation on the Vertical Distribution of Heat in the Gulf of Mexico. Proc. of 4th OTEC Symposium, P. IV-26, G. Ioup. (ed l).

5. Martin, P. J. and G. O. Roberts (1978). Peak Current Profile Estimates at Selected Sites for Ocean Thermal Energy Conversion. SAI Tech. Report, Science Applications, Inc., 8400 Westpark Drive, McLean, VA.

6. Martin, P. J. and J. D. Thompson (1979). Formulation and Testing of a Layer-Compatible Upper Ocean Mixed-layer Model. Paper submitted to Journal of Physical Oceanography.

7. Mellor, G. L. and T. Yamada (1974). A Hierarchy of Turbulence Closure Models for Planetary Boundary Layers. J. Atmos. Sci., 31, 1791-1806.

8. Mellor, G. L. and P. A. Durbin (1975). The Structure and Dynamics of the Ocean Surface Mixed Layer. J. Phys. Oceanog., 5, 718-725.

9. Pollard, R. T. and R. C. Millard (1970). Comparison Between Observed and Simulated Wind-generated Inertial Oscillations. Deep Sea Res., 17, 813-821.

II. SYSTEM SUMMARY

A. BACKGROUND

The ever-increasing sophistication of the Navy's various underwater detection systems has made knowledge of the thermal structure of the upper ocean of prime importance to the Fleet. For example, the performance of both active and passive sonar systems is closely linked to the depth of the upper mixed layer of the ocean. Also, the decay of submarine wakes in the upper ocean depends critically on the weak stratification of the mixed layer.

The thermal structure of the upper ocean is frequently and substantially modified by the passage of atmospheric disturbances. In addition, the diurnal solar heating cycle alters this structure in an important way. Presently, however, the Navy has no capability to forecast changes in the thermal structure of the upper ocean and must rely on a daily analysis of very sparse data to construct a best guess of the existing thermal field.

B. OBJECTIVES

The main objective of the HMLMS is to provide FNWC with the capability to perform 72 hour forecasts of changes in the upper ocean thermal structure forced directly by fluxes of heat, moisture, and momentum across the air-sea interface. Furthermore, the HMLMS can form the basis of a system, not described in this report, whereby data input to the Ocean Thermal Structure Analysis can be supplemented by model-predicted temperature profiles. This system, which is similar to the 24 hour update cycle of the FNWC PE model, would put much more information into the analysis program than is currently possible and tend to make the resulting analyzed fields dynamically consistent with the atmospheric forcing. This may significantly improve the analyzed ocean thermal structure, particularly in data-sparse regions.

C. EXISTING METHODS AND PROCEDURES

FNWC currently has no capability to dynamically forecast changes in the thermal structure of the upper ocean. Persistence or climatology provide the only alternatives presently available.

D. PROPOSED METHODS AND PROCEDURES

The HMLMS is a forecast model of the upper ocean which consists of conservation equations for heat, salinity, and horizontal momentum solved on the standard FNWC Northern Hemisphere 63 x 63 Polar Stereographic Grid with 17 levels in the vertical. It is initialized and driven by data fields routinely available on the FNWC System. In the present version of the model, geostrophic currents and horizontal and vertical advection of all quantities are assumed to be zero.

1. Turbulence Parameterization

The Level-2 turbulence closure theory of Mellor and Yamada (1974) is used to parameterize the vertical eddy fluxes of heat, salinity, and momentum. This turbulence parameterization model has been applied to the upper mixed layer of the ocean with success by Mellor and Durbin (1975), Martin (1976), Martin and Roberts (1977), Martin and Roberts (1978), Martin and Thompson (1979), and Clancy (1979).

2. Internal Wave Parameterization

The damping of inertial oscillations in the mixed layer due to downward propagation of internal wave energy is parameterized with a constant damping coefficient in the manner suggested by Pollard and Millard (1970).

3. Solar Radiation Parameterization

Absorption of solar radiation in the upper ocean is modeled using the Type I extinction profile for clear ocean water from Jerlov (1951).

4. Initial Conditions

a. Temperature

The initial temperature field is taken from the most recent Ocean Thermal Structure Analysis produced by the FNWC Operational System. The model can accept input from either the Expanded Ocean Thermal Structure (EOTS) analysis system or the older Ocean Thermal Structure (OTS) analysis system.

b. Salinity

Salinity is carried in the model, since it makes an important contribution to the density stratification in some regions and thereby affects the vertical turbulent mixing. The initial salinity field is taken from monthly climatology maintained at FNWC. In addition, an option exists in the model which allows the salinity to be adjusted slightly from climatology in order to guarantee that: (1) the initial density stratification below the Primary Layer Depth (PLD), provided by the Ocean Thermal Structure Analysis, does not fall below some user-specified minimum value, and (2) the inital density stratification from the PLD to the surface is neutral. This option can be particularly advantageous in high latitudes where anomalous salinity distributions often allow strong temperature inversions to exist at the base of the mixed layer.

c. Momentum

The horizontal momentum is initially assumed zero below the PLD. From the PLD to the surface, the horizontal momentum is initially taken to vary linearly such that the vertically averaged flow in this region is equal to the vertically averaged Ekman drift, assuming zero stress at the PLD. This treatment greatly reduces the amplitude of the inertial oscillations caused by the initial

switching on of the wind stress and allows the various fields to adjust to one another and the surface forcing much more rapidly than would be the case if the initial flow field was set to zero everywhere.

5. Boundary Conditions

a. Upper Boundary Conditions

The upper boundary conditions for the differential equations are supplied by the fluxes of heat, moisture and momentum at the sea surface predicted by the FNWC operational atmospheric models.

b. Lower Boundary Conditions

Time-invariant lower boundary conditions on temperature, salinity and momentum are imposed at a depth of 500 m. The temperature here is determined by linearly extrapolating the temperature predicted by the analysis program down to this level. Similarly, the salinity at this depth is determined by downward extrapolation of the salinity provided by the climatological data base. Momentum is set to zero at the lower boundary.

c. Lateral Boundary Conditions

Since the horizontal advection of all quantities is neglected in the model, no lateral boundary conditions are required.

6. Vertical Grid

The vertically stretched grid consists of 17 levels between the surface and 500 m depth. The depth of each of the levels is given in Table 1. Note that high vertical resolution (i.e., 5 m) is provided near the surface. Note also that every fixed level in the EOTS Analysis System is represented as a gridpoint in the model.

7. Numerical Scheme

The parabolic conservation equations for heat, salinity and momentum are solved by forward time differencing. The Coriolis terms and all vertical diffusion (i.e., eddy flux) terms are treated implicitly.

E. SUMMARY OF IMPROVEMENTS

The HMLMS will provide FNWC with a capability that it does not presently have: the capability to produce 72 hour forecasts of changes in the thermal structure of the upper ocean. The model will be useful for forecasting upper ocean modification due to the passage of atmospheric high and low pressure areas and their associated warm and cold fronts. In addition, it will successfully predict the diurnal variation in mixed layer depth and stratification due to solar heating. Because of the reasons cited in section II. A, these products will be of value to the Fleet.

TABLE 1

VERTICAL GRID

GRIDPOINT NUMBER	DEPTH (m)
1	2.5
2	7.5
3	12.5
4	17.5
5	25.0
6	32.5
7	40.0
8	50.0
9	62.5
10	75.0
11	100.0
12	125.0
13	150.0
14	200.0
15	300.0
16	400.0
17	500.0

F. SUMMARY OF IMPACTS

1. Equipment Impact

No additional equipment is required for this project.

2. Software Impacts

No changes in, or additions to, existing support software are required for this project.

3. Organizational Impacts

Although the primary responsibility for performing the OPSCHKOUT and OPSEVAL procedures on this system will be with FNWC personnel, NORDA Code 322 will render whatever assistance is necessary to facilitate this process.

4. Operational Impacts

Because of the minimal amount of computer resources required (see section III. A) and the routine availability of needed data fields (see section III. B), the impact of this model on the operational system will be negligible.

5. Developmental Impacts

The bulk of the development work on this system has been completed. If problems arise during the OPSCHKOUT phase, it is anticipated that they can be solved via updates to the OPSPL file.

G. EXPECTED LIMITATIONS

It must be stressed that this model is capable of forecasting only the changes in the upper ocean that are forced directly by fluxes of heat, moisture, and momentum across the air-sea interface. Over most of the ocean, these fluxes do control the time evolution of the upper ocean thermal structure on the 3-day time scale. However, in western boundary currents, near strong oceanic fronts, and in regions of intense upwelling, advective processes can make an important contribution to, or perhaps even dominate, the time evolution of the upper ocean. In these special regions, the model may not perform well.

Furthermore, it must be realized that the model predictions will be only as good as the available data allow: if the initial conditions provided by the Ocean Thermal Structure Analysis and the climatological salinity data base are bad, then the model forecast will be equally as bad. In addition, the model can produce realistic results only if the surface fluxes predicted by the FNWC atmospheric models are realistic.

Finally, it should be noted that the model will be limited by the lack of a synoptic analysis for salinity. Thus, in regions where anomalous salinity

distributions (i.e., those differing from climatology) make a significant contribution to the density stratification, the model may not perform well.

III. DETAILED CHARACTERISTICS

A. SPECIFIC PROCEDURES AND RESOURCE REQUIREMENTS

The HMLMS System consists of three major components: Program SETUP, Program MAIN, and Program PICTURE.

Program SETUP, which accesses the necessary data fields, sorts them, and writes the sorted fields on scratch Disk files for subsequent input to the forecast model, requires about 124 K_8 words of CM. However, the program uses no ECS and executes only about 1.9 CP minutes on the SPC in preparation for a 72 hour forecast.

Program MAIN, which comprises the actual forecast model, uses only about 51 K_8 words of CM, no ECS, and executes about 8.4 CP minutes on the SPC for a 72 hour forecast.

Program PICTURE, which produces ZRANDIO records of selected model output fields for subsequent input to the standard FNWC VARIMAP plotting package, requires about 53 K_8 words of CM, no ECS, and executes less than 0.2 CP minutes on the SPC.

The scratch disk space required by all of the components is well within the FNWC mass storage limit.

B. DATA REQUIREMENTS

1. Ocean Thermal Structure Data

If the model is to be initialized with data from the OTS Analysis System, the most recent version of the products listed in Table 2 must be available. These quantities are routinely accessible on MASFNWC from the SPC.

If the model is to be initialized with data from the EOTS Analysis System, the most recent version of the products listed in Table 3 must be available. These quantities are not maintained on SPC. However, they can be easily restored from the appropriate OTSDUMP tape using standard FNWC Routine RSTRZIO.

2. Climatological Salinity Data

The climatological salinity fields for the appropriate month listed in Table 4 must be available to initialize the model. These fields are maintained on CLIMAST for the current month and are easily accessible from SPC.

3. Surface Flux Data

The products generated by the FNWC atmospheric models listed in Table 5 are required to provide the surface forcing for the model. All of these fields at the designated forecast times are easily accessible on MASFNWC from SPC.

TABLE 2

OCEAN THERMAL STRUCTURE DATA FIELDS REQUIRED TO INITIALIZE THE MODEL FROM THE OTS ANALYSIS SYSTEM

DATA ENTRY NUMBER	FNWC CATALOG NUMBER	DEFINITION OF DATA FIELD
1	B38	Primary layer depth (PLD)
2	P32	Temperature at PLD
3	P39	Gradient 100 ft above PLD
4	P31	Thermocline gradient
5	P40	Gradient 100 ft below PLD
6	B10	Sea surface temperature
7	P14	Surface to 200 ft gradient
8	P15	200 to 400 ft gradient
9	P16	400 to 600 ft gradient
10	P17	600 to 800 ft gradient
11	P18	800 to 1000 ft gradient
12	P19	1000 to 1200 ft gradient

TABLE 3

OCEAN THERMAL STRUCTURE DATA FIELDS REQUIRED TO

INITIALIZE THE MODEL FROM THE EOTS ANALYSIS SYSTEM

DATA ENTRY NUMBER	FNWC CATALOG NUMBER	DEFINITION OF DATA FIELD
1	AAA	Primary layer depth (PLD)
2	AAB	Temperature at PLD
3	AAC	Gradient 25 m above PLD
4	AAD	Gradient 12.5 m below PLD
5	AAE	Gradient between 12.5 and 25 m below PLD
6	AAF	Gradient between 25 and 50 m below PLD
7	AAI	Sea surface temperature
8	AAQ	Surface to 25 m gradient
9	AAR	25 to 50 m gradient
10	AAS	50 to 75 m gradient
11	AAT	75 to 100 m gradient
12	AAU	100 to 125 m gradient
13	AAV	125 to 150 m gradient
14	AAW	150 to 200 m gradient
15	AAX	200 to 250 m gradient
16	AAY	250 to 300 m gradient
17	AAZ	300 to 400 m gradient

TABLE 4

CLIMATOLOGICAL SALINITY DATA FIELDS

REQUIRED TO INITIALIZE THE MODEL

DATA ENTRY NUMBER	FNWC CATALOG NUMBER	DEFINITION OF DATA FIELD
1	S0000 ?	Salinity at surface
2	S0025 ?	Salinity at 25 m depth
3	S0050 ?	Salinity at 50 m depth
4	S0100 ?	Salinity at 100 m depth
5	S0150 ?	Salinity at 150 m depth
6	S0200 ?	Salinity at 200 m depth
7	S0400 ?	Salinity at 400 m depth

? = A, B, C,...L for month = Jan., Feb., March,... Dec.

TABLE 5

DATA FIELDS REQUIRED TO PROVIDE THE SURFACE FLUXES FOR THE MODEL

DATA ENTRY NUMBER	FNWC CATALOG NUMBER	DEFINITION OF DATA FIELD	TAU (Forecast Time in Hours)
1	A35	Boundary layer wind speed (PBL model)	*
2	A36	Boundary layer wind direction (PBL model)	*
3	A11	Solar radiation flux (PE model)	*
4	A18	Total heat flux (PE model)	*
5	A52	Evaporative heat flux (PE model)	*
6	A62	Precipitation (PE model)	**

* = 0, 6, 12, 18, 24, 30, 36, 42, 48, 54, 60, 66, 72

** = 12, 24, 36, 48, 60, 72

C. SYSTEM FUNCTIONS AND I/O FILE STRUCTURE

The basic function of each program module and the I/O file structure are given below. A schematic diagram of the flow of program control and data is given in Figure 1.

1. Program SETUP

This program and its associated subroutines access the required data fields on the FNWC System, and produce three sorted data files (on scratch Disk file units 11, 12, and 13) for subsequent input to the forecast model.

The first logical record on unit 11 contains 7 words of miscellaneous data to be passed to the forecast model. The remaining ISEA logical records on unit 11 contain the Ocean Thermal Structure Data at each sea gridpoint in the 63 x 63 grid, where ISEA is the total number of sea gridpoints. The number of words on each of these logical records will be either 12 or 17, depending on whether the data is taken from the OTS Analysis System or the EOTS Analysis System (see Tables 2 and 3). The order of the data entries in each logical record will be the same as given in either Table 2 or Table 3.

The file on unit 12 contains ISEA logical records, with each record containing the climatological salinity data at a sea point in the 63 x 63 grid. Each record contains 7 words of data arranged in the order shown in Table 4.

Unit 13 contains ISEA groups of 13 logical records in each group for a total of ISEA*13 logical records. The Nth record in the Kth group contains the surface flux data at the Kth sea point in the 63 x 63 grid for TAU (i.e. forecast time in hours) equal to 6* (N-1). Thus, for example, the 18th logical record on unit 13 contains the surface flux data at the second sea gridpoint for TAU=24. Each of these logical records contains 6 data entries arranged in the order shown in Table 6. The components of the surface wind stress (US,VS) are determined using a bulk aerodynamic drag coefficient. The net surface heat flux is given by the difference between the total heat flux (A18) and the solar radiation flux (A11).

The total number of sea gridpoints ISEA, varies from week to week with the extent of the ice coverage. In sweeping through the 63 x 63 grid, the column index is always assumed to vary more rapidly than the row index.

a. Subroutine OLREAD

This routine reads ZRANDIO formatted data fields from MASFNWC.

b. Subroutine DUMWRT

This routine writes scratch Disk files necessary for temporary storage.

c. Subroutine DUMLOAD

This routine writes scratch Disk files necessary for temporary storage.

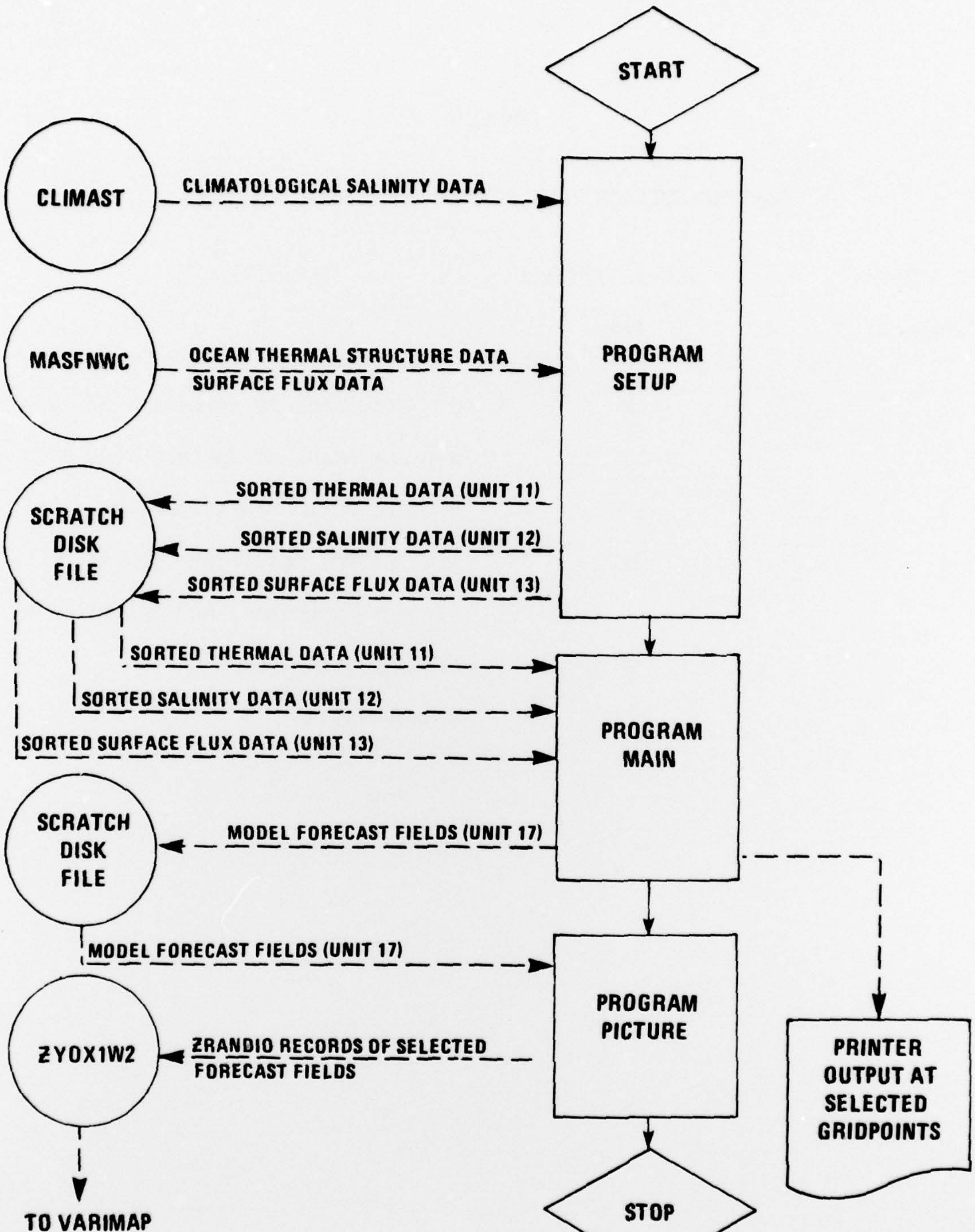

Figure 1. Schematic diagram showing flow of program control (⟶) and data (- - →) through the system.

TABLE 6

DERIVED SURFACE FLUX FIELDS INPUT TO THE MODEL

DATA ENTRY NUMBER	MODEL VARIABLE NAME	DEFINITION
1	US	E-W component of surface wind stress
2	VS	N-S component of surface wind stress
3	QR	Surface solar radiation flux
4	TS	Net surface heat flux (sum of surface latent, sensible, and infrared)
5	QE	Surface latent heat flux
6	PE	Precipitation

2. Program MAIN

This program is the driver of the forecast model. It initializes constants, coordinates the flow of data into and out of the model, and controls the numerical integration procedure.

a. Subroutine TSET

This routine initializes certain parameters to specific values, depending on whether the Ocean Thermal Structure Data is taken from the OTS Analysis System or the EOTS Analysis System.

b. Subroutine LOCAL

This routine controls the initialization of all quantities that vary from point to point in the 63 x 63 grid.

c. Subroutine TINITL

This routine reads the Ocean Thermal Structure data from unit 11 and initializes the vertical temperature profiles. The file structure for the data on unit 11 is given in section III. C. 1.

d. Subroutine SINITL

This routine reads the climatological salinity data from unit 12 and initializes the vertical salinity profile. The file structure for the data on unit 12 is given in section III. C. 1.

e. Subroutine UVINITL

This routine initializes the vertical momentum profile such that the flow, vertically averaged from the surface to the PLD, is equal to the vertically averaged Ekman drift.

f. Subroutine SFLUX

This routine reads the surface flux data from unit 13 and stores them for interpolation in time. The file structure for the data on unit 13 is given in section III. C. 1.

g. Subroutine EDDYCO

This routine calculates the vertical profiles of the eddy diffusion coefficients for heat, salinity, and momentum.

h. Subroutine POTDEN

This routine calculates the density of sea water at atmospheric pressure as a function of temperature and salinity.

i. Subroutine FDS1

This routine performs the finite difference update for each time step.

j. Subroutine TRIDIA

This routine solves a system of linear equations, for which the matrix of the coefficients is tri-diagonal, as required by the implicit finite difference scheme.

k. Subroutine PENDIA

This routine solves a system of linear equations, for which the matrix of the coefficients is penta-diagonal, as required by the implicit finite difference scheme.

l. Subroutine HANNIN

This routine applies a Hannin smoother to the vertical profile of the eddy diffusion coefficients in order to increase the stability of the numerical scheme.

m. Subroutine SFNEW

This routine updates the surface fluxes every time step by interpolating between the values stored at 6 hour intervals and read by Subroutine SFLUX. The components of the surface wind stress (US, VS), the surface latent heat flux (QE), and the net surface heat flux (TS, i.e. the sum of the surface latent, sensible, and infrared heat fluxes) are interpolated linearly in time. The surface solar radiation flux (QR) is set proportional to the local zenith angle of the sun, which varies sinusoidally in space and time. The amplitude of this flux is allowed to vary linearly in time (to account for changes in cloud cover) such that the resulting curve passes through all of the points supplied at 6 hour intervals by the FNWC atmospheric models. The surface precipitation (PE) represents accumulated rainfall over the previous 12 hours and is available only at 12 hour intervals. It is used to determine a time-averaged precipitation rate for each of these 12 hour periods. Thus, for each successive 12 hour period of the forecast, the model sees a constant precipitation rate.

n. Subroutine ZENITH

This routine calculates the zenith angle of the sun, for interpolation of the solar flux by SFNEW, as a function of latitude, longitude, hour of the day, and day of the year.

o. Subroutine PRNTDA

This routine prints the predicted fields on the line printer at selected time intervals at selected points in the 63 x 63 grid.

p. Subroutine SAVE

This routine writes the forecast fields of interest onto unit 17 (a scratch Disk file) for subsequent input to program PICTURE. The first logical record on unit 17 contains 12 words of miscellaneous data and is written by program MAIN. The remainder of unit 17 is written by subroutine SAVE and consists of 3969 groups of (72/ISAVE +1) logical records in each group for a total of 3969* (72/ISAVE + 1) logical records. Here ISAVE is the user-specified time in hours between saves of the forecast fields and 3969 is the total number of points in the 63 x 63 grid. The Nth record in the Kth group contains the forecast fields, at the Kth point in the grid for TAU (i.e., forecast time in hours) equal to (N-1)*ISAVE. Thus, for example, if ISAVE=12, the 11th logical record on unit 17 contains the forecast data at the second gridpoint for TAU=24 (recall that the first logical record on the file contains miscellaneous data). Each of the records containing forecast data have 18 data entries arranged in the order shown in Table 7. Dummy data is stored at land points in the grid. Output of additional fields (density for example) can be accomplished by a trivial modification of the program.

3. Program PICTURE

This program and its associated subroutines access the model forecast fields written on unit 17 by program MAIN and produce VARIMAP-compatible ZRANDIO records of selected fields (or differences of selected fields between two forecast times) on file ZY0X1W2.

a. Subroutine TREAD

This routine reads the data off unit 17 and selects the field (or difference of two fields) of interest. File structure for the data on unit 17 is given in section III.C.2.p.

b. Subroutine LAND

This routine assigns dummy values to a field at land gridpoints such that, when it is plotted using land/sea discrimination, the contours of the field will cut across the coastline in a smooth and consistent fashion.

c. Subroutine CREATE

This routine writes a ZRANDIO record (complete with standard 20 word header information) of a 63 x 63 field on file ZY0X1W2.

D. MATHEMATICAL ACCURACY

The CYBER 170 60-bit/word floating point hardware is more than sufficient to handle all calculations.

E. TIMING

Timing information for the major program components is given in section III. A.

TABLE 7

SAVED DATA FIELDS WRITTEN ON UNIT 17 FOR

SUBSEQUENT INPUT TO PROGRAM PICTURE

DATA ENTRY NUMBER	DEFINITION OF FIELD
1	MIXED LAYER DEPTH (CM)
2	TEMPERATURE AT LEVEL 1 (°C)
3	TEMPERATURE AT LEVEL 2 (°C)
4	TEMPERATURE AT LEVEL 3 (°C)
5	TEMPERATURE AT LEVEL 4 (°C)
6	TEMPERATURE AT LEVEL 5 (°C)
7	TEMPERATURE AT LEVEL 6 (°C)
8	TEMPERATURE AT LEVEL 7 (°C)
9	TEMPERATURE AT LEVEL 8 (°C)
10	TEMPERATURE AT LEVEL 9 (°C)
11	TEMPERATURE AT LEVEL 10 (°C)
12	TEMPERATURE AT LEVEL 11 (°C)
13	TEMPERATURE AT LEVEL 12 (°C)
14	TEMPERATURE AT LEVEL 13 (°C)
15	TEMPERATURE AT LEVEL 14 (°C)
16	TEMPERATURE AT LEVEL 15 (°C)
17	TEMPERATURE AT LEVEL 16 (°C)
18	INITIAL PRIMARY LAYER DEPTH (CM)

F. INPUT/OUTPUT

The standard FNWC data fields accessed by the system are discussed in section III. B and summarized in Tables 2-5. The flow of data through the system is illustrated by Figure 1, and the model-generated file structure is discussed in sections III. C. 1 and III.C.2.(p).

G. DATA STORAGE

Data storage requirements are given in section III. A.

H. FAILURE CONTINGENCIES

If required data fields are missing, program SETUP displays an appropriate message to the operator, and a list of missing fields and associated information is printed on the line printer in standard format. Because of its low CP time requirements, restart capability is not currently maintained in the system. This could be added to later versions, however, if it is found desirable.

IV. ENVIRONMENT

A. EQUIPMENT ENVIRONMENT

The following hardware is required by the HMLMS system:

1. CYBER 175 mainframe computer

2. Rotating mass storage to hold required data files

3. A Varian plotter

B. SUPPORT SOFTWARE ENVIRONMENT

The following support software is required:

1. FNWC Library (FNWCLIB)

2. Standard CDC Mathematical Function Library

3. Standard CDC System Library

C. INTERFACES

The HMLMS interfaces with the operational system in the manner outlined in sections III.C. 18 and III.C. 3 and schematically illustrated by Figure 1. All I/O of fields to the operational data base is done using standard FNWC routines ZRANDIO and CLIMRD.

D. SECURITY

The only possible security consideration relating to this system is the use of Ocean Thermal Structure Analyses that are produced, in part, from classified data. This should pose no problem, however, since the analysis

process removes the identity of the input data and the HMLMS operates completely within the confines of the FNWC computer environment.

V. COST FACTORS

This system was developed largely within the FNWC computer system. Because of adequate machine time availability, computer resources were not a limiting factor. A prototype version of the model using dummy data sets was developed on the CDC 6600 at Eglin Air Force Base, at a total cost of about $2K. Total man years expended in this effort was 0.75 MY.

The model is expected to take about 10.5 CP min/72 hr forecast on the Cyber 175 (see section III. A). Since it is the first ocean forecast model installed on the system, no comparison can be made as to cost effectiveness.

VI. DEVELOPMENTAL PLAN

The following documentation will be produced by 15 June 1979 in support of this project:

- User's Manual
- Computer Operator's Manual
- Program Maintenance Manual

Each of these manuals will be written in a flexible format so that revised documentation can be incorporated if necessary. Additional technical reports and scientific articles on forecast evaluation studies of the system will also be forthcoming.

This system is the first in a hierarchy of models that will be delivered to FNWC by NORDA Code 322. The second product, to be delivered 15 August 1979, will be an extension of the present system that will include a simplified treatment of advective processes. One or both of these models will eventually be interfaced with the Ocean Thermal Structure Analysis System in a 24 hour update cycle as discussed briefly in section II. B. Finally, hydrodynamical and combined hydrodynamical-thermodynamical models to be run on the PEPS upgrade computer will be delivered by NORDA at later dates to provide FNWC with a steadily improving capability to analyze and forecast the oceanic environment throughout the 1980's.

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Unclassifed

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER NORDA Technical Note 45	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) 6 THE NORDA HEMISPHERIC MIXED LAYER MODEL SYSTEM (HMLMS): A FUNCTIONAL DESCRIPTION		5. TYPE OF REPORT & PERIOD COVERED 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) 10 R. Michael Clancy		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Naval Ocean Research & Development Activity NSTL Station, Mississippi 39529		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 12 27
11. CONTROLLING OFFICE NAME AND ADDRESS Naval Ocean Research & Development Activity NSTL Station, Mississippi 39529		11 12. REPORT DATE April 1979 13. NUMBER OF PAGES 20
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Unlimited **DISTRIBUTION STATEMENT A** Approved for public release; Distribution Unlimited		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Ocean Forecast Model Ocean Thermal Structure Oceanic Mixed Layer		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This technical note describes a forecast model for the thermal structure of the upper ocean developed for Fleet Numerical Weather Central (FNWC) by NORDA Code 322. Brief discussions of the capabilities and limitations of the model, its software design, and its impacts on and interfaces with the FNWC operational system are given.		

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE
S/N 0102-LF-014-6601

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

392 773

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